1880MNRAS..40..430D

The possible Ten-Month Period of Variation in Latitude.

By A. M. W. Downing, Esq.

If from any cause the axis of rotation of the Earth does not coincide with the axis of figure the former will revolve round the latter in a period which is equal to

$$\frac{A}{C-A},$$

employing the notation usual in works on dynamics. The most probable value of this period appears to be 306 mean solar days. The apparent pole of the Earth would therefore travel round the pole of the adjacent principal axis in this time, and give rise to what may be called a ten-month period of variation in latitude as determined from meridian zenith distances of stars observed above and below the pole. Clerk Maxwell has examined (*Trans. Edin. R. S.* vol. xxi. p. 569) the observations of *Polaris* made at the Royal Observatory, Greenwich, during the years 1851–4 to ascertain whether any period of this kind could be detected in the resulting latitudes, the apparent co-latitude being found from the observations made during each month. There appeared to be a slight indication of a maximum in 1851 March, 1852 Feb., 1852 Dec., 1853 Nov., and 1854 Sept. The author considers, however, that "this result is to be regarded as very doubtful," and that "more observations would be required to establish the existence of so small a variation at all."

In the present paper I have discussed the Greenwich observation of *Polaris* made during the ten years 1868–1877, with the view of determining the amount of this variation (if it exists), and also the time of maximum effect.

The zenith distances of *Polaris*, as extracted from the volumes of *Greenwich Observations*, have been corrected, where necessary, for errors in the screws of the microscope-micrometers by applying the quantities given in the Introduction to the Nine-Year Catalogue; also for error in the Transit-Circle thermometer, a correction of $-0^\circ{\cdot}5$ being applied to all readings, and the corresponding correction applied to the zenith distance. The refractions used are those of Bessel's *Tabulæ Regiomontanæ.* The correction for discordance of direct and reflexion observations has been also applied.

The observations have then been grouped—usually by months, except in cases where there is an insufficient number of observations, either above or below the pole. The apparent co-latitude has then been formed from the observations of each group, the effect of uncorrected aberration and of annual parallax being practically eliminated by this method of treating the observations. The following table exhibits the series of co-latitudes

1880MNRAS..40..430D

thus formed—the degrees and minutes being 38° 31′ in all cases:—

	1868.	1869.	1870.	1871.	1872.	1873.	1874.	1875.	1876.	1877.
	″	″	″	″	″	″	″	″	″	″
Jan.	22·12	22·28	—	—	21·92	21·96	—	—	—	22·32
Feb.	21·77	—	—	—	—	—	—	—	—	21·62
March	21·99	22·14	22·25	22·61	21·66	21·52	21·65	22·20	21·88	21·97
April	21·45	21·98	21·40	23·29	21·65	21·50	21·21	21·43	21·25	21·65
May	22·10	21·56	21·24	22·14	21·83	21·92	21·69	21·72	21·39	21·86
June	21·84	21·07	21·81	21·53	21·46	21·37	21·12	21·41	21·51	21·39
July	21·55	—	21·38	21·63	—	21·84	20·71	21·76	21·28	20·52
August	21·73	—	21·98	—	—	21·62	—	21·37	21·29	21·70
Sept.	21·48	—	21·55	21·61	21·64	21·59	22·02	21·64	21·50	20·86
Oct.	22·19	21·65	21·16	21·39	21·55	21·57	21·92	22·28	22·08	21·77
Nov.	22·41	21·93	21·70	21·98	21·70	21·87	22·05	22·46	21·81	21·96
Dec.	21·89	22·51	22·96	21·88	22·15	22·36	21·82	22·89	22·50	21·52

There appears, therefore, to be an annual variation in the Greenwich apparent co-latitudes (the possibility of the existence of which was pointed out by me in *M. N.* vol. xl. p. 86), but there is no variation with a ten-month period of any considerable amount.

I proceed now to calculate the amount of the latter variation, assuming its period to be 306 days.

Let r be the angular distance between the moveable and fixed poles, and θ the angle which the great circle joining them makes with the Greenwich meridian, referred to the fixed pole, at the time 1872·0. Also let ϕ be the apparent co-latitude, and ϕ_0 the co-latitude referred to the fixed pole, then we have

$$\begin{aligned}\phi &= \phi_0 + r\cos\{\theta + 429{\cdot}4(t - 1872)\}\\ &= \phi_0 + r\cos\theta\cos 429{\cdot}4(t-1872) - r\sin\theta\sin 429{\cdot}4(t-1872).\end{aligned}$$

Let

$x = r\cos\theta,$

$y = r\sin\theta,$

$z =$ correction to the assumed value of ϕ_0, $38^\circ\ 31'\ 21''{\cdot}90$,

$n = 38^\circ\ 31'\ 21''{\cdot}90 - \phi;$

then the equations of condition are of the form

$$ax + by + cz + n = 0.$$

If m and m' be the number of observations above and below the pole respectively in each group, the weight of the resulting

1880MNRAS..40..430D

apparent co-latitude, and therefore of the corresponding equation of condition, is

$$\frac{4mm'}{m+m'}.$$

Equations of conditions have been formed in this manner for each of the determinations of co-latitude (100 in number) given in the table above; these have been solved by the method of least squares, and the following normal equations obtained:—

$$\begin{aligned} +629{\cdot}66x + 11{\cdot}78y + 10{\cdot}58z + 44{\cdot}08 &= 0, \\ +11{\cdot}78x + 544{\cdot}25y + 7{\cdot}88z + 18{\cdot}76 &= 0, \\ +10{\cdot}58x + 7{\cdot}88y + 1179{\cdot}\ z + 105{\cdot}86 &= 0. \end{aligned}$$

From these I find

$$\begin{aligned} x &= -0''{\cdot}068 \pm 0''{\cdot}015, \\ y &= -0{\cdot}032 \pm 0{\cdot}016, \\ z &= -0{\cdot}089 \pm 0{\cdot}011. \end{aligned}$$

the probable error of a single determination of co-latitude of weight unity being

$$\pm 0''{\cdot}384.$$

From the above values of x and y we have

$$\begin{aligned} r &= 0''{\cdot}075 \pm 0''{\cdot}015, \\ \theta &= 205^\circ{\cdot}0 \quad \pm 6^\circ{\cdot}7. \end{aligned}$$

Although the value thus found for r is so small, still it will be remarked that it is five times greater than its probable error; so that, supposing we may assume that the variation in question remains constant for ten years, its reality may be asserted with some degree of confidence. But it is evidently much too small to be detected by mere inspection of the observations, which appears to have been the only process resorted to by Clerk Maxwell in the paper referred to above.

The value of θ which I have found indicates that the apparent latitude of Greenwich was a maximum on 1872, Oct. 12. Now, Prof. C. A. F. Peters, in his well-known work *Recherches sur la parallaxe des étoiles fixes*, has investigated this question of variability of latitude, making use of the Pulkowa observavations of *Polaris* from 1842 March to 1843 April. He found $r=0''{\cdot}079 \pm 0''{\cdot}017$, and for the time when the latitude of Pulkowa was a maximum 1842 Nov. 16. If the variation remain constant the latitude should, therefore, again have been a maximum on 1872 Nov. 16; and the longitude of Pulkowa being 2^h east, the latitude of Greenwich would be maximum $\frac{1}{12}$ of the

1880MNRAS..40..433D

period, or about 26 days earlier; that is, about 1872, Oct. 21. Prof. Peters' results, therefore, agree remarkably with mine, both as to the magnitude of the variation and the time of its maximum effect.

On the other hand, Dr. Nyrén, from a thorough discussion of three series of Pulkowa observations made by Peters, by Gyldén, and by himself, has arrived at discordant results, and concludes that there is no constancy of magnitude or phase in the variation of apparent latitude. Dr. Nyrén's investigation is contained in his paper entitled *Die Polhöhe von Pulkowa.* There appears, therefore, to be this difficulty about the question—that if a short series of observations is used we cannot be sure that we have satisfactorily got rid of accidental errors, or of errors (possibly) depending on the refraction having periods of twelve months, or of six months; and if we discuss a sufficiently long series of observations to eliminate these errors, we make what may be an illegitimate assumption—viz., that the variation remains constant.

The co-latitude of Greenwich deduced from the ten-years' observation of *Polaris* is

$$38^\circ\ 31'\ 21''{\cdot}811 \pm 0''{\cdot}011.$$

Blackheath,
1880, *May* 10.

On a Photograph of Jupiter's Spectrum showing Evidence of Intrinsic Light from that Planet. By Henry Draper, M.D.

There has been for some years a discussion as to whether the planet *Jupiter* shone to any perceptible extent by his own intrinsic light, or whether the illumination was altogether derived from the Sun. Some facts seem to point to the conclusion that it is not improbable that *Jupiter* is still hot enough to give out light, though perhaps only in a periodic or eruptive manner.

It is obvious that spectroscopic investigation may be usefully employed in the examination of this question and I have incidentally, in the progress of an allied inquiry,* made a photograph which has sufficient interest to be submitted to the inspection of the Astronomical Society.

If the light of *Jupiter* is in large part the result of his own incandescence it is certain that the spectrum must differ from that of the Sun, unless the improbable hypothesis is advanced that the same elements, in the same proportions and under the same physical conditions, are present in both bodies. Most of

---

* See paper *On Photographing the Spectra of the Stars and Planets,* read before the American National Academy of Sciences, Oct. 28, 1879, and published in *Nature,* Nov. 27, 1879, and in the *American Journal of Science,* Dec. 1879.